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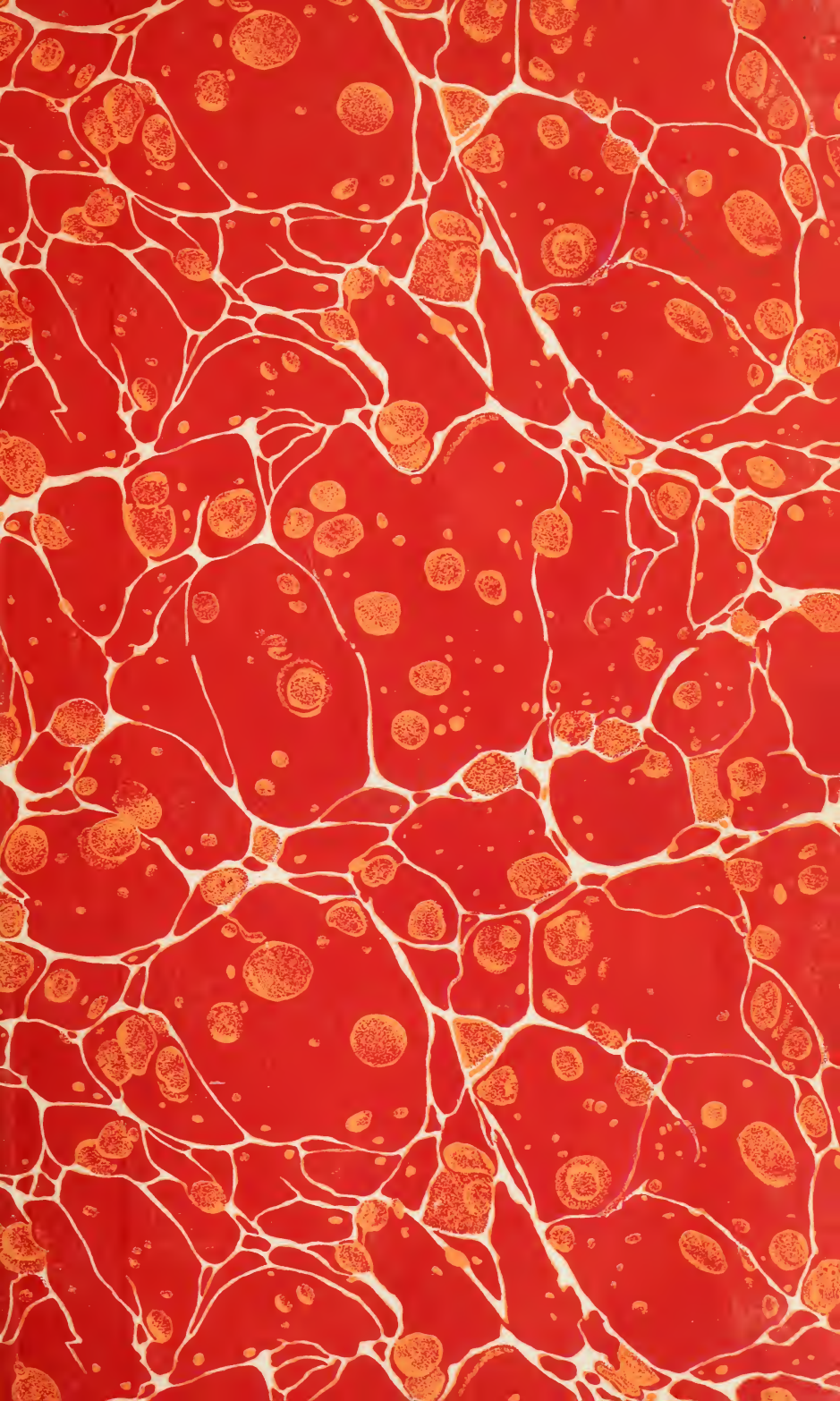
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PATHOLOGICAL CONDITIONS ASCRIBED TO
NEMATODES IN POULTRYBy ELOISE B. CRAM, Zoologist, Zoological Division
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INTRODUCTION

The pathological significance of species of nematodes occurring in domestic birds has been emphasized to a considerable extent, but in most instances the subject has been regarded from the point of view of a particular parasite and its specific pathogenicity. It seems worth while to look at the problem from the opposite point of view, with the pathological condition as a primary consideration, and to assemble the individual reports of specific action of nematodes according to the effect produced. In this manner one may gain an idea of the variety of deleterious effects which have been ascribed to the presence of nematodes, and of the species of nematodes which have been reported as associated with such conditions. Upon finding a pathological condition in a domestic bird one may then be better able to judge of the possibility of its being of parasitic origin.

STRIKING CLINICAL SYMPTOMS

Certain clinical symptoms or other external ante-mortem changes have been described as caused by nematodes, the most important of which are given in the following paragraphs.

INJURY TO EYES

Injury to the eyes of domestic fowls is by its nature one of the most striking and most easily discernible of these conditions. Inflammation of varying intensity, at times so severe as to cause blindness and in some cases even complete destruction of the eyeball, may result from infestation with Manson's eye worm, *Oxyuris mansonii*, in the chicken. Similar damage is produced by *O. parvovum*, the species found in chickens in Australia. Kobayashi (9)¹ has made a microscopical study of the pathology of *O. mansonii* and finds that

¹ Italic numbers in parentheses refer to "Literature cited," p. 10.

the papillae and follicles on the nictitating membrane are remarkably increased, pathological changes being present which are somewhat similar to those seen in trachoma. An eye symptom of a different sort is the loss of pigmentation of the iris of pigeons, which has been noted as one of the most marked features associated with severe infestations with *Dispharynx spiralis*, which is located in the glandular stomach.

RESPIRATORY CHANGES

Change in the rate of breathing in fowls is also an easily noted condition. Dyspnea and finally asphyxiation result directly from the presence of gapeworms in the trachea and bronchi; *Syngamus trachea* may cause such symptoms in chickens, pheasants, and quail, resulting in the death of the birds; a similar effect is produced in domestic geese and domestic ducks by *Cyathostoma bronchialis*. In addition, this clinical effect is said to result indirectly from infestation of the crop of ducks with *Capillaria contorta*, the distended crop compressing the pneumogastric nerve, with interference of breathing and resulting asphyxiation. Difficult breathing is also described as a symptom of infestation of the gizzard of geese and ducks with *Amidostomum anseris*.

CLINICAL EFFECTS OF A CHRONIC NATURE

CACHEXIA, ANEMIA, AND GENERAL TOXIC EFFECTS

Cachexia, including emaciation, anemia, and general toxic effects, has been described as caused by a considerable number of nematodes. As regards gapeworms, *Syngamus trachea* chiefly in chickens and pheasants, and occasionally in the turkey, and *Cyathostoma* in domestic geese and ducks, are said to have this effect. Worm infestations of the upper digestive tract, as *Capillaria annulata* in the esophagus of turkeys and chickens, and *C. contorta* in the esophagus of ducks, and also infestations of the stomach, as with *Dispharynx spiralis*, *Streptocara pectinifera*, and *Cheilosporura hamulosa* in chickens, and *Amidostomum anseris* in domestic geese and ducks react similarly on the health of the bird. Intestinal worms, as *Hartertia gallinarum* in the chicken; species of *Ascaridia*, as *A. columbae* in the pigeon, and *A. lineata* in the chicken; and species of *Capillaria*, as *C. retusa* in the chicken and *C. columbae* in the pigeon and chicken, have also been reported as producing this condition.

PARALYSIS OR MARKED INCOORDINATION

Symptoms of paralysis and marked incoordination are reported as associated with *Capillaria contorta* in the duck, and with *C. retusa* and *Ascaridia galli* in the chicken; in the last case the paresis in one outbreak, reported by Rovis (12), completely clearing up when large numbers of *A. galli* were removed by treatment. Drooping wings and ruffled feathers, with increasing weakness which gives the appearance of paralysis, are described by Ackert and Herrick (3) in chicks experimentally parasitized with *A. lineata*, these symptoms being caused by loss of blood, impaired appetite, and a decided retardation of muscular and osteological development. (Fig. 1.)

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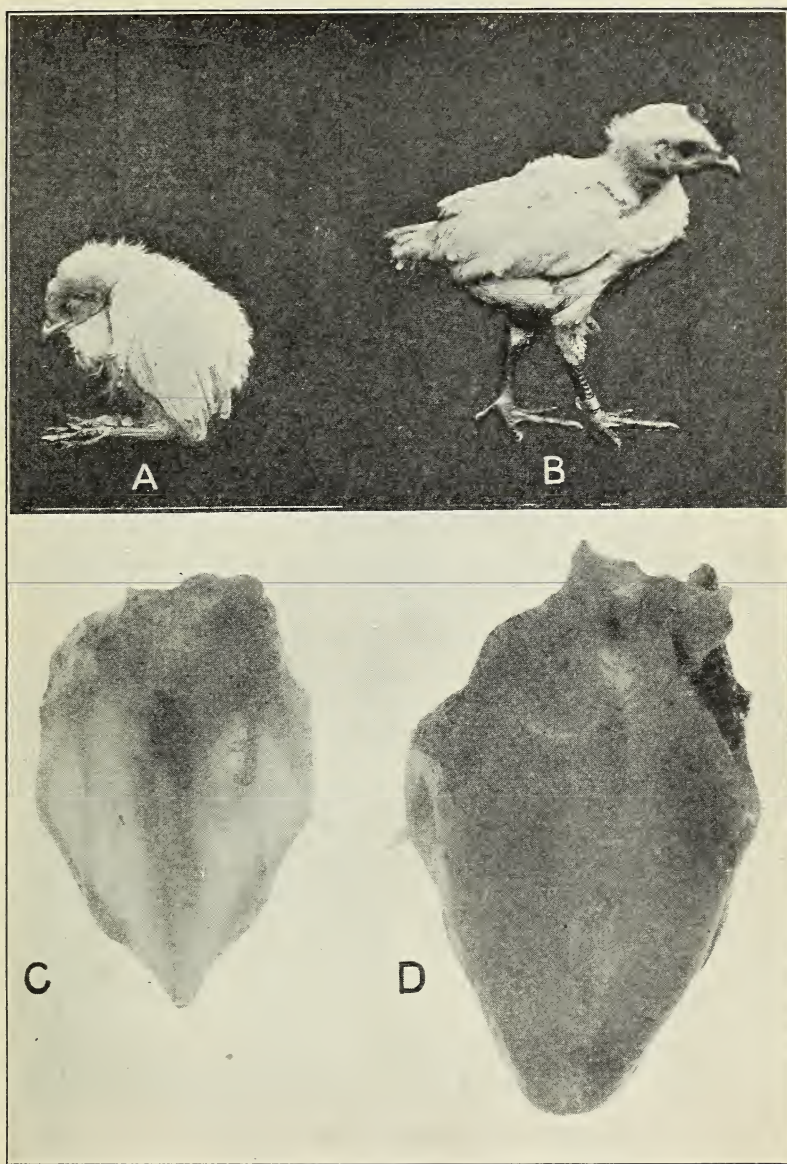


FIGURE 1.—A.—Parasitized chick (No. 584) at fourteenth day of parasitism; fed embryonated eggs at age of 14 days; typical of fatal cases; heavily infested. B.—Control chick (No. 649) from the same hatch; 8 grams heavier at beginning of experiment; 68 grams heavier two weeks later, when picture was taken. C.—Breast of chick 584, parasitized. D.—Breast of control chick 649. (After Ackert and Herrick, 1928)

EFFECTS ON APPETITE

The appetite is said not to be affected by *Streptocara pectinifera* in chickens; it is described as greatly increased by *Dispharynx nasuta* in chickens, and by *D. spiralis* in chickens and pigeons, the birds eating ravenously up to the time of their deaths. On the other hand, loss of appetite is observed in connection with infestations with the eye worm, *Oxyspirura mansoni*; with gapeworms, *Syngamus trachea* and *Cyathostoma bronchialis*; with *Ascaridia lineata* of chickens and *A. columbae* of pigeons; with capillarids of the crop, *C. contorta* of ducks and *C. annulata* of chickens and turkeys; and with stomach worms, *Tetrameres fissispina* of ducks and chickens, and *Amidostomum anseris* of ducks and geese. In *Ascaridia lineata* infestations, the appetites of the chicks, which during the early stage of the disease are greatly reduced, later become voracious if the chicks survive.

DIARRHEA

Diarrhea is said to result from *Tetrameres fissispina* in the glandular stomach of ducks and chickens, the food not digesting, and an excess of bile, the secretion of which is stimulated, producing a greenish diarrhea; in addition, diarrhea in chickens may be caused by *Heterakis gallinae* and by *Strongyloides avium* in the ceca.

PATHOLOGICAL CHANGES DUE TO NEMATODES

Pathological changes which are revealed at post-mortem examinations are of varied nature and include the following.

INFLAMMATION OF DIGESTIVE TRACT

In the esophagus, both dilated and undilated portions, local lesions in the form of burrows, surrounded by areas of slight inflammation, may be caused by *Gongylonema ingluvicola* in chickens, by *Capillaria annulata* in chickens, turkeys, and quail, and by *C. contorta* in ducks; in the case of capillarid infestations the inflammation may become very severe, with thickening of the wall as the mucosa becomes catarrhal and later croupous, with sloughing off of the membrane. (Fig. 2.) In the glandular stomach a catarrhal condition, with thickening of the wall, may be caused by *Dispharynx spiralis* in chickens and pigeons; by *D. nasuta* (fig. 3), *Tetrameres fissispina* and *T. americana* in chickens; and by *Amidostomum anseris* and *Echinuria uncinata* in domestic waterfowl. The lining of the gizzard may be destroyed and the muscular wall invaded by *A. anseris* in water birds, and by *Cheilosporura hamulosa* (fig. 4) and *Streptocara pectinifera* in chickens.

An enteritis, at times severe, may be caused by species of *Capillaria* (*C. meleagris-gallopavo* and *C. retusa* in chickens and turkeys, *C. columbae* in chickens and pigeons, and *C. collaris* in chickens); by species of *Ascaridia* (*A. galli* and *A. lineata* in chickens, and *A. columbae* in pigeons); and by *Hartertia gallinarum* in chickens, all in the small intestine. Severe and sometimes fatal cases of typhlitis are reported as caused by *Heterakis gallinae* and *Strongyloides avium* in chickens. In the majority, if not in all, of these parasitic infestations of the digestive tract there is more or less tissue invasion at some time in the life history. The immature forms of *Ascaridia*

lineata have been shown by Ackert to bury their heads deeply in the intestinal wall, with resultant destruction of the intestinal glands (fig. 5), from the tenth to the seventeenth day after the infection is acquired by the chick, the worms thereafter withdrawing to the



FIGURE 2.—Thickening of the walls and sloughing of the mucosa of the crop undilated esophagus, caused by *Capillaria annulata*. To the left, specimens of the nematodes which have been extracted from the mucosa. (After Cram, 1929)

lumen. *Heterakis gallinae* invades the mucosa of the ceca in a similar manner in the early stages. In other cases, as with *Strongyloides avium* in the ceca, with species of *Capillaria* in the small intestine, and with *Dispharynx spiralis* in the glandular stomach, the adults are to be found in close association with the mucosa, although not

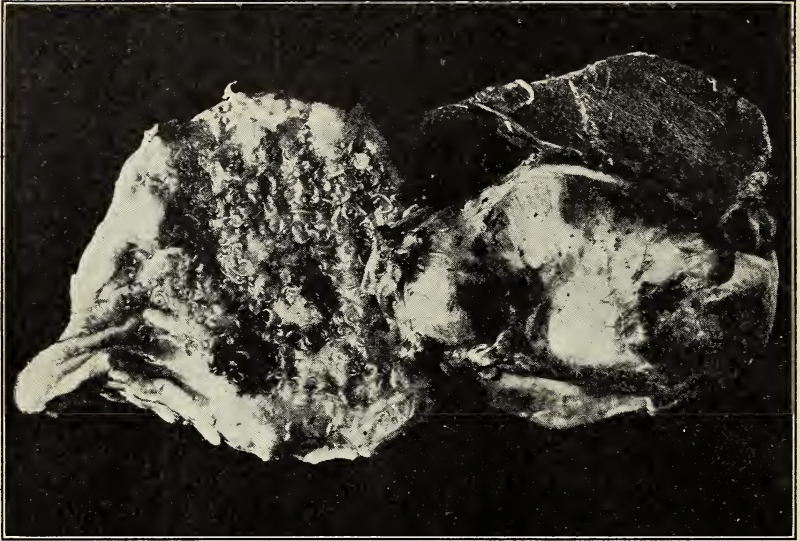


FIGURE 3.—*Dispharynx nasuta* in the glandular stomach of chicken, showing catarrhal condition of mucosa and thickening of wall. (From Department of Agriculture and Stock, Brisbane, Australia. Furnished through courtesy of P. Rumball)

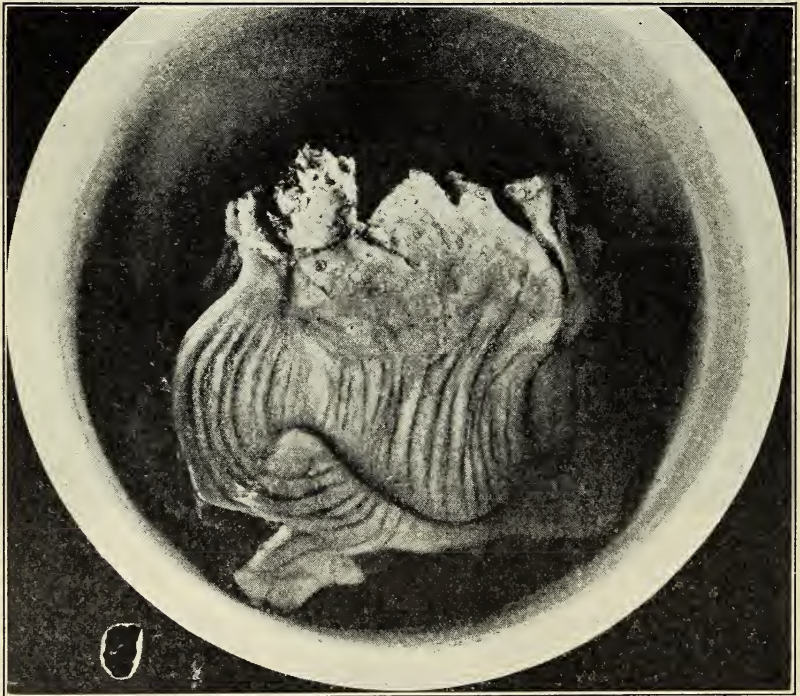


FIGURE 4.—Damage to the muscular wall of gizzard, caused by *Cheilospirura hamulosa*

actually burrowing to the extent that the species of *Capillaria* in the esophagus or the species of gizzard worms burrow in the wall.

NODULE OR TUMOR FORMATION

Invasion of the wall of the digestive tract may lead to the formation of nodules or tumors. The larvae of *Heterakis beramporia* were found by Schwartz (13) in the Philippines to cause a nodular disease of the ceca; both larvae and adults of *H. isolonche* act similarly in pheasants. Bedel (6) has reported verminous nodules in

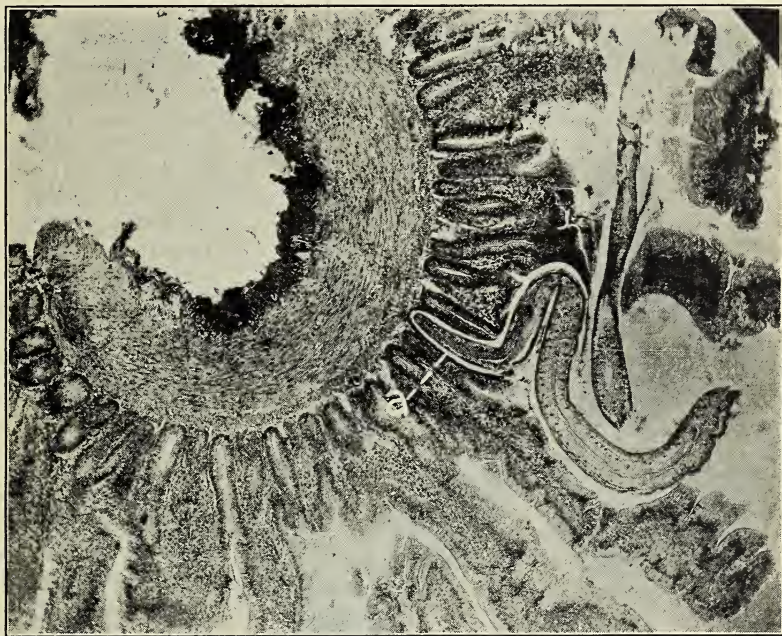


FIGURE 5.—Section through the small intestine of young chick showing larva of *Ascaridia lineata* in wall of intestine, anterior end extending through Lieberkühn's glands into mucosa; a, Disappearance of tissue. (After Ackert)

the liver and intestinal walls in connection with *Ascaridia columbae* in the pigeon. Itagaki (8) describes a severe nodular disease of the intestines of chickens which is of comparatively common occurrence in Japan in winter and midsummer, and is caused by the larvae of what he calls *A. perspicillum* (probably *A. lineata* or *A. galli*) which penetrate the wall of the intestine during those seasons that are considered adverse for parasitic development; in spring and autumn the larvae do not penetrate the wall. In waterfowl more pronounced nodules, or in severe cases actual tumors are produced in the esophagus and stomachs by *Echinuria jugadornata* (fig. 6), by *E. uncinata*, by *Hystrix tricolor*, and by *Eustrongylides mergorum*. An increased tendency to the formation of neoplasms has been noted by Baker and his coworkers (5) in chickens which have survived the acute stage of infestations with *A. lineata* and *H. gallinae*.

STENOSIS (CONSTRICTION)

Stenosis may follow from severe inflammatory reactions or from nodules or tumors in the walls of the digestive tract, and the nematodes previously listed as associated with such conditions may, therefore, be the cause of stenosis.

IMPACTION OR OCCLUSION

Impaction or occlusion may result from the presence of parasitic nematodes. Occlusion of the bronchi and trachea of chickens may be caused by *Syngamus trachea*, and of waterfowl by *Cyathostoma bronchialis*. The nasal passages of chickens may be occluded by *Oxyuris mansoni*. This nematode is sometimes present in large numbers, Niles (cited by Ransom, 10) having seen as many as 200 worms in one chicken in Florida. Intestinal impaction may be

caused in chickens by *Ascaridia lineata* or by *A. galli*, instances of heavy infestations being comparatively common, and in pigeons by *A. columbae*, of which up to 500 specimens have been found in one bird.

RUPTURE

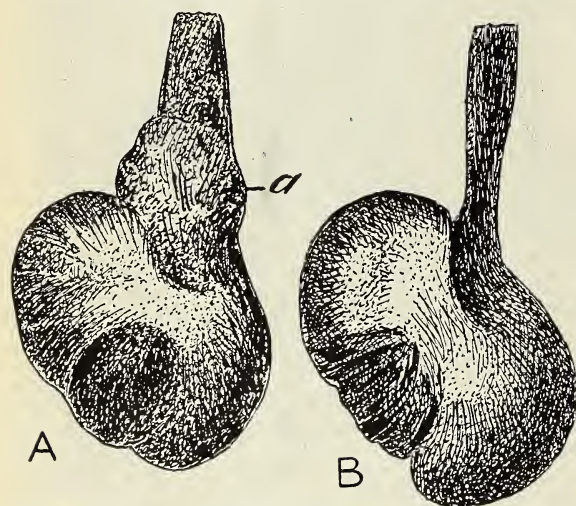


FIGURE 6.—Two stomachs of ducks: A, With tumor (a), due to *Echinuria jugadornata*; B, normal. (From Skrjabin, 1916, after Soloviev, 1912)

(11) states that this nematode, which was present in more than 50 per cent of the chickens examined by him in South Africa, may weaken the wall to such an extent as to cause it to rupture, with ultimate formation of a sac. The sac, gradually filling with ingesta forced into it by the muscular contractions of the gizzard, may finally occupy the whole of the abdomen.

HEMORRHAGE AND OTHER DAMAGE TO CIRCULATORY SYSTEM

Hemorrhage is an additional damage which may be caused by nematodes. During the period of the invasion of the intestinal wall by the young forms of *Ascaridia lineata*, Ackert and Herrick (3) found evidence of blood in the feces. Punctiform hemorrhages of the intestine of pigeons are found in cases of *A. columbae* infestation. In chickens, *Capillaria collare*, and in turkeys, *C. meleagris*-

gallopavo are reported as causing small hemorrhages of the intestine. Specimens of *Ornithostrongylus quadriradiatus* when collected from the intestine of the pigeon are bright red from the ingestion of blood, and the intestinal contents of the bird contain abundant erythrocytes. Evidence of hemorrhage is clearly present in *Amidostomum anseris* infestations of waterfowl, the necrotic tissue of the walls of the upper digestive tract, especially of the gizzard, being stained with blood pigment.

The cardio-vascular system has been shown to be affected by infestations with nematodes. Baker and his coworkers (5) report marked distention of the vessels of the parenchymatous organs and a noticeable enlargement of the heart in connection with experimentally produced cases of *Ascaridia lineata* and *Heterakis gallinae* in chickens.

OBSCURE PHYSIOLOGICAL CHANGES

Changes of a more obscure nature, which may be caused by nematodes, include injury to the thymus gland, which Ackert (2) has noted in connection with *Ascaridia lineata*, the gland in infected chickens of 2 to 3 months of age averaging less than half the weight of the gland in uninfected chickens of the same age. Reduction of the sugar content of the blood is another highly significant change which has been noted by Ackert and Titus (4) as accompanying infestation with this nematode.

A deposit of urates in the ureters and in and upon the pericardium and myocardium also may result from *Ascaridia lineata* and *Heterakis gallinae* infestations.

SECONDARY INFECTIONS AS RESULTS OF NEMATODE ACTIVITY

Lastly, nematodes may make possible other infections in poultry. Worms which injure the intestinal tract may open the way for *Bacillus coli*, definite evidence of which was obtained in the study of the disease known as strongylosis, caused by *Trichostrongylus pergracilis* in grouse in England. In cases in which large numbers of the nematodes were present in the ceca, with chronic inflammation of the walls, *B. coli* was demonstrable in the liver, lungs, and other organs. The damage to the lungs caused by gapeworms in chickens and water birds may incite secondary infections resulting in pneumonia. The Oklahoma Agricultural Experiment Station (7) has reported a fatal pneumonia as resulting from large numbers of larvae of *Ascaridia lineata* in chickens, but as other workers have failed to find migration of such larvae from the intestine, the case appears to have been exceptional and requires confirmation. Introduction of another parasite by a species of nematode is illustrated by the transmission of the organisms of blackhead through the eggs of the cecum worm, *Heterakis gallinae*, of poultry.

SUMMARY

A brief review of the instances of reported pathogenicity of the nematodes of poultry indicates a wide range of pathological conditions which may result from such parasitism. Gross examination of living birds may show the eyes directly or indirectly affected by parasitic nematodes; clinical symptoms of internal parasitism include dyspnea and asphyxiation, a chronic condition of cachexia, emaciation, or retardation of growth, and anemia, deranged appetite, diar-

rhea, and paralysis or muscular incoordination. Pathological changes which have been observed include inflammation of the various parts of the digestive tract, formation of nodules or of tumors, stenosis, impaction or occlusion, rupture, production of hemorrhages, changes in the cardio-vascular system, deposit of urates, injury to the thymus gland, reduction of sugar content of the blood, and the facilitating of the entry of other infections. The species of nematodes which are reported as causing these conditions represent various taxonomic groups, so there is no evidence that a pathological significance is restricted to any one group. Critical study, such as Ackert and his coworkers have given to *Ascaridia lineata*, with the effects of experimentally produced infestation compared with control, that is, nonparasitized cases, is highly desirable in order that the subject may be further clarified.

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